

“Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster.” By W. A. HERDMAN, D.Sc., F.R.S., Professor of Zoology in University College, Liverpool, and RUBEY BOYCE, M.B., Professor of Pathology in University College, Liverpool. Received December 24, 1898,—Read January 19, 1899.

(Abstract.)

This research was commenced three years ago, and has been carried on intermittently in the intervals of other work.

Preliminary reports on some of our results have been laid before the British Association at the Ipswich, Liverpool, Toronto, and Bristol meetings, and a short paper on one section of the subject was communicated to the Royal Society and printed in the ‘Proceedings’ last year. In the present paper we give a full account, with illustrations, of the detailed evidence upon which our various conclusions are based. The following is a brief statement of the more important results given in the paper :—

1. Although our primary object was to study the oyster under unhealthy conditions, in order to elucidate its supposed connection with infective disease, we found it necessary to study in minute detail the histology of certain parts of the body, especially the gills and mantle lobes, the alimentary canal and liver. We give figures and descriptions of these structures in both normal and abnormal conditions.

2. We have also worked out the distribution and probable function of a minute muscle, which we believe to be the modified representative of the protractor pedis muscle of some other molluscs.

3. A diseased condition we found in certain American oysters very soon brought us into contact with the vexed question of the “greening” of oysters, and one of the first results we arrived at was that there are *several distinct kinds* of greenness in oysters. Some of them, such as the green Marennes oysters, and those of some rivers on the Essex coast, are healthy; while others, such as some Falmouth oysters, containing copper, and some American oysters re-bedded on our coast, and which have the pale-green “leucocytosis” described in our former paper to the Royal Society, are not in a healthy state.

4. Some forms of greenness (*e.g.*, the leucocytosis) are certainly associated with the presence of a greatly increased amount of copper in the oyster, while other forms of greenness (*e.g.*, that of the Marennes oysters) have no connection with copper, but depend upon the presence of a special pigment, “marennin.”

We are able, in the main, to support Ray Lankester in his observa-

tions on Marennes oysters; but we regard the wandering amoeboid granular cells on the surface of the gills as leucocytes which have escaped from the blood spaces, and have probably assumed a phagocytic function.

5. We see no reason to think that any iron which may be associated with the marennin in the gills, &c., is taken in through the surface epithelium of the gill and palps, but regard it, like the rest of the iron in the body, as a product of ordinary digestion and absorption in the alimentary canal and liver.

6. We do not find that there is any excessive amount of iron in the green Marennes oyster compared with the colourless oyster, nor do the green parts (gills, palp, &c.) of the Marennes oyster contain either absolutely or relatively to the colourless parts (mantle, &c.) more iron than colourless oysters. We therefore conclude that there is no connection between the green colour of the "Huitres de Marennes" and the iron they may contain.

7. On the other hand, we do find by quantitative analysis that there is more copper in the green American oyster than in the colourless one; and more proportionately in the greener parts than in those that are less green. We therefore conclude that their green colour is due to copper. We also find a greater quantity of iron in those green American oysters than in the colourless; but this excess is, proportionately, considerably less than that of the copper.

8. In the Falmouth oysters, containing an excessive amount of copper, we find that much of the copper is certainly mechanically attached to the surface of the body, and is in a form insoluble in water, probably as a basic carbonate. In addition to this, however, the Falmouth oyster may contain a much larger amount of copper in its tissues than does the normal colourless oyster. In these Falmouth oysters the cause of the green colour may be the same as in the green American oyster.

9. By treating sections of diseased American oysters under the microscope with potassium ferrocyanide and various other reagents, we find that the copper reactions correspond in distribution with the green coloration; and we find, moreover, from these micro-chemical observations that the copper is situated in the blood-cells or leucocytes, which are greatly increased in number. This condition may be described as a green leucocytosis, in which copper in notable amount is stored up in the leucocytes.

10. We find that an aqueous solution of pure hæmatoxylin is an extremely delicate test for copper, just as Macallum found it to be for iron.

11. Experiments in feeding oysters with weak solutions of various copper and iron salts gave no definite results, certainly no clear evidence of any absorption of the metals accompanied by "greening."

12. Although we did not find the *Bacillus typhosus* in any oysters obtained from the sea or from the markets, yet in our experimental oysters inoculated with typhoid we were able to recover the organism from the body of the oyster up to the tenth day. We show that the typhoid bacillus does not increase in the body or in the tissues of the oyster, and our figures indicate that the bacilli perish in the intestine.

13. Our experiments showed that sea-water was inimical to the growth of the typhoid bacilli. Although their presence was demonstrated in one case on the twenty-first day after addition to the water, still there appeared to be no initial or subsequent multiplication of the bacilli.

14. In our experiments in washing infected oysters in a stream of clean sea-water the results were definite and uniform; there was a great diminution or total disappearance of the typhoid bacilli in from one to seven days.

15. The colon group of bacilli is frequently found in shell-fish as sold in towns, and especially in the oyster; but we have no evidence that it occurs in mollusca living in pure sea water. The natural inference that the presence of the colon bacillus invariably indicates sewage contamination must, however, not be considered established without further investigation.

16. The colon group may be separated into two divisions: (1) those giving the typical reactions of the colon bacillus, and (2) those giving corresponding negative reactions, and so approaching the typhoid type; but in no case was an organism giving all the reactions of the *B. typhosus* isolated. It ought to be remembered, however, that our samples of oysters, although of various kinds and from different sources, were in no case, so far as we are aware, derived from a bed known to be contaminated or suspected of typhoid.

17. We have shown also the frequent occurrence, in various shell-fish from the shops, of anaërobic spore-bearing bacilli giving the characteristics of the *B. enteritidis sporogenes* recently described by Klein.

18. As the result of our work, we make certain recommendations as to the sanitary regulation and registration of the oyster beds, and as to quarantine for oysters imported from abroad.

“On the Formation of Multiple Images in the Normal Eye.” By
SHELFORD BIDWELL, M.A., LL.B., F.R.S. Received December
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[PLATE 5.]

It is well known that a small bright object for which the eye is not accommodated often presents a multiform appearance, the number of separate images perceived varying in different cases from about six to